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[Insert title of invention]

Background of Invention

[0001] *METHOD FOR MANUFACTURING A MULTI-TUBE FLUORESCENT DISCHARGE LAMP*

[0002] *1. Field of the Invention*

[0003] The Invention relates to fluorescent discharge lamps, and more particularly, to a method for a multi-tube fluorescent discharge lamps which construct multiple glass tubes of different caliber in coaxial structure, the both sides of the inner most tube are connected to a cathode respectively, by isolating, perforating and blocking the discharge path, forming successive discharge chambers, and coating fluorescent material on surface of the discharge tubes. The Invention can then have more fluorescent area than a conventional fluorescent lamp of the similar size and higher lumen as well as power transfer factor. Compared with the power consumption of a conventional fluorescent discharge lamp, the Invention therefore has higher luminous flux.

[0004] *2. Description of the Prior Art*

[0005] Generally, a conventional fluorescent discharge lamp uses one straight or round tube. To minimize the size and to increase the illumination, there is a kind of compact fluorescent discharge lamp that the straight tube is bent into a wreath or U type. Alternatively, couples of short straight fluorescent tubes are aligned and connected in parallel, on the both terminations of the tube with a cathode tungsten filament that coated with oxide such as Ba, Sr and Ca. In the discharge tube is in a state of vacuum and with little Hg and Ar, which helps the discharge.

[0006] The conventional fluorescent lamp tubes is usually a round cross-section and only one layer of fluorescent material such as phosphor is coated on the surface of the tube inside. When the cathodes on both sides of the tube is started up by current and high-voltage power is applied to the cathodes on both sides of tube, the electron is released between the two cathodes and make the tube glow discharge. The Ar and Hg vapor molecules are also stimulated to create plasma; the ion and ultraviolet rays also impact the phosphor, so that the potential energy is transferred into light from the phosphor.

[0007] Because the cross-section area of a round tube is larger than that of any shape, the average density of electronic flux of the round tube inside is lower than other shape of tube. Furthermore, the electronic flux on the discharge path is concentrated nearby the axis of the discharge tube; the density of the electronic flux nearby the surface of the discharge tube inside gets lower.

[0008] Therefore, the luminous flux in a round tube can not in proportion to raise by increasing the diameter of the tube to expand the area of phosphor, much of energy nearby the axis in the discharge tube will be depleted and transfer into heat, the transferring factor of the lumen (Lm) and Watt (W) remains not high enough.

[0009] Although there is another kind of lamp which build-in a lot of segmented tubes and coated with phosphor to increase the illuminant fluorescent area, but the lamp does not forming a successive discharge path, therefore, it does not guarantee stable discharge path or equable plasma status, nor adequate and complete illumination of fluorescent layer in the discharge tube, because the discharge path proceeds in the shortest distance.

[0010] Moreover, due to the narrow spectrum of conventional fluorescent discharge lamp, the color-rendering index (Ra) is low and the color temperature (K) is high which therefore causes the illuminated object unable to reveal its colors. Besides, for the cathode on both sides of the conventional fluorescent discharge lamp is hit by electron, the tungsten filament is then vaporized to be black and pollutes the fluorescent layer of the tube, hence reduces the illumination efficiency of the

fluorescent layer as well as the life cycle of the fluorescent discharge lamp.

Summary of Invention

[0011] This Invention is a multi-tube fluorescent discharge lamp; the design concept of the Invention is constructed of multiple discharge glass tubes of different caliber in coaxial structure. By isolating, perforating and blocking the discharge path, and applying phosphor on surface of the discharge tubes, a thin and transparent film of fluorescent coating is then created, allowing the light of the inner tubes pass through each of the coatings to the outside of the lamp. In addition, a pair of cathodes as hot or cold cathode helps the electronic flux in the vacuum to be accelerated and hit the Hg molecule, which is then stimulated to create plasma. The coating of fluorescent on the inner layer surface of the discharge tube is impacted by electron ion and UV rays and then to emits light. Under the same power rate and with the same volume of lamp, the tubes of the multi-tube fluorescent discharge lamp aligned in coaxial structure have smaller cross-section area than that of conventional fluorescent discharge lamp so that this Invention can allow higher density of electron flux to pass through the discharge path in the tubes. Therefore, the high-density electron ion has better stimulating effects on the fluorescent coating and the illuminant fluorescent area is larger than conventional fluorescent discharge lamp, both advantages increasing the luminous flux.

[0012] Compared to conventional fluorescent discharge lamp of the same power rate, this Invention is characterized by higher luminance, lower consumption of electric power and lower heat rate. Moreover, because the electric flux of the Invention is less than that of conventional fluorescent discharge lamp, the vaporization caused by electric flux hitting the cathode gets slower and the life cycle of the cathode is longer accordingly than that of conventional fluorescent discharge lamp. It is also feasible to apply ringed cathode to increase the surface area of the hitting of electron flux and then disperse the hitting, so that the oxide material on the surface of the cathode can be protected from rapid consumption. By this way, the multi-tube fluorescent discharge lamp can outlive conventional fluorescent discharge lamp.

[0013] The multi-tube fluorescent discharge lamp whose surface is coated with various fluorescent material of different colors temperature. The fluorescent material, being stimulated, can release fluorescence of different spectrum and create special colors after mixing. Alternatively it can include wider spectrum to improve the color temperature (K) as well as color-rendering index (Ra) to be close to the sun spectrum.

[0014] The multi-tube fluorescent discharge lamp is designed in coaxial structure, aiming to achieve special colorful luminance or balanced spectrum range of light by way of filtering the luminance released from the transparent discharge glass tube of different colors.

[0015] The characteristics of this Invention can be specifically presented by the following detailed figures.

Brief Description of Drawings

[0016] FIG.1 is a partly broken side view of a conventional fluorescent discharge lamp.

[0017] FIG.2 to FIG.9 are cross-sectional views and end views showing a step-by-step process of fabrication of a three-tube fluorescent discharge lamp of a first embodiment.

[0018] FIG.10 is a cross-sectional view and end view of the five-tube combination with phosphor of a second embodiment.

[0019] FIG.11 is a cross-sectional view and end view of an electrode portion with a straight cathode.

[0020] FIG.12 is a cross-sectional view and end view of an electrode portion with a ring cathode.

[0021] FIG.13 is a cross-sectional view and end view of a cap.

[0022] FIG.14 is a cross-sectional view and end view of a cap combined an electrode portion with a straight cathode.

[0023] FIG.15 is a cross-sectional view and end view of a cap combined an electrode portion with a ring cathode.

[0024] FIG.16 and FIG.17 are cross-sectional view to follow the FIG.9 showing a step-by-step process of fabrication of the three-tube fluorescent discharge lamp of the first embodiment.

[0025] FIG.18 is a cross-sectional view of a three-tube fluorescent discharge lamp of a third embodiment.

[0026] FIG.19 is a cross-sectional view of a dual-tube fluorescent discharge lamp of a fourth embodiment.

[0027] FIG.20 is a cross-sectional view showing a five-tube portion and a pair of electrode portions of the five-tube fluorescent discharge lamp of the second embodiment.

[0028] FIG.21 is a cross-sectional view of the three-tube fluorescent discharge lamp of the first embodiment showing a pair of bases unattached.

[0029] FIG.22 is a cross-sectional view of the full schematic three-tube fluorescent discharge lamp of the first embodiment.

[0030] FIG.23 is a cross-sectional view of the full schematic five-tube fluorescent discharge lamp of the second embodiment.

[0031] FIG.24 is a partly broken and cross-sectional view of the full schematic three-tube fluorescent discharge lamp of the first embodiment.

[0032] FIG.25 is a partly broken and cross-sectional view of the full schematic five-tube fluorescent discharge lamp of the second embodiment.

Detailed Description

[0033]

According to Figure 1, illustrates a conventional fluorescent discharge lamp. The discharge tube 8 is a straight glass tube, on both sides of the tube are the cathodes 26 whose electrode 28 are connected to the terminal 42 of the tube base

40. The figure explains clearly that there is only one phosphor layer 18 on the surface of the tube inside. In addition, because the density of electronic flux nearby the axis of the discharge tube is higher than that the electronic flux nearby the phosphor layer 18 of the discharge tube inside. Therefore, much of energy nearby the axis in the discharge tube will be depleted and transfer into heat, the power transfer factor of the lumen needs to be improved.

[0034] According to FIG.2, the first tube 10 is a round straight glass tube, which is the inner most tube in the multi-tube fluorescent discharge lamp and are where the cathodes 26 located.

[0035] According to FIG.3, to use as a flame of gas and oxygen or arc heating around the circumference in the vicinity of the middle of the first tube 10 for softening and is rotated in the reverse direction around both ends of the tube, and is twisted at the softening place thus fusing into an isolator 12 to seal the pipeline nearby the middle of the tube to insulate and separating the discharge path of the first tube 10 into two discharge chambers.

[0036] According to FIG.4, blowing the air in from both ends of the first tube 10, also heating is performed nearby both ends of isolator 12 on the two circumferences at the position of plural number thus the through-hole 14 of plural number are formed.

[0037] According to FIG.5, the second tube 16 is a round straight glass tube of which the diameter is slightly larger than that of the first tube 10, at one end of the second tube 16 is air tight and the air is blown in from another end, or air is blown in from both ends, also heating is performed nearby both ends on the two circumferences at the position of plural number thus the through-hole 14 of plural number are formed.

[0038]

According to FIG.6, the first tube 10, after passing through the holes, is slid into the second tube 16 in coaxial structure then heating on the circumference of the second tube 16 correspond to the position of isolator 12 of the first tube 10, also, rotation is made with reverse direction at both ends of the second tube 16,

and is twisted at the softening place of the tube thus fusing into another isolator 12 with the first tube 10 to seal the pipeline of the second tube 16 and separating the discharge path of the second tube 16 into two discharge chambers.

[0039] According to FIG.7, phosphor layer 18 is coated on the inner and outer layer surface of the first tube 10 and the second tube 16.

[0040] According to FIG.8, the third tube 20 is a round straight glass tube of which the diameter is slightly larger than that of the second tube 16, the phosphor layer 18 is coated on the inner layer surface of the third tube 20.

[0041] According to FIG.9, this combination of the first tube 10 and the second tube 16 can be slid into the third tube 20 in coaxial structure.

[0042] According to FIG.10 and refer to the FIG.6, just as the combination of the first tube 10 and the second tube 16 to be slid into the third tube 20 in coaxial structure that the diameter of the third tube 20 which is slightly larger than that of the second tube 16, heating is performed on the circumference of the third tube 20 correspond to the isolator 12 of the second tube 16, also, rotation is made with reverse direction at both ends of the third tube 20 and is twisted at the softening place of the third tube 20 for fusing with the isolator 12 of the second tube 16, then to connect and form an isolator 12 of the third tube 20 to seal the pipeline of the third tube 20 and separate the discharge path of the third tube 20, to allow the air being blown in at both ends of the third tube 20, also, heating shall be performed on the circumference at both ends of 20 to approach the isolator 12 of the second tube 16 at the position of plural number thus the through-hole 14 with plural number are formed.

[0043]

Also, with a glass tube of the fourth tube 22, which the diameter is slightly larger than that of the third tube 20, to slide into the combination of the first tube 10, the second tube 16, and the third tube 20 into the fourth tube 22 in coaxial structure, heating on the circumference of the fourth tube 22 approach to the isolator 12 of the third tube 20, at both ends of said the fourth tube 22 is rotated in reverse direction, and twisted at the softening place of the fourth tube 22 for

fusing with the isolator12 of the third tube 20 for connecting and forming an isolator 12 of the fourth tube 22 to seal the pipeline of the fourth tube 22, separating the discharge path of the fourth tube 22, thus forming two discharge chambers so that air can be blown in from both ends of the fourth tube 22, also, heating is performed on the circumference to approach both ends of the fourth tube 22 and at the position of plural number, thus extruding through-holes14 with plural number.

[0044] The phosphor layer 18 is formed at the inner and outer layer surface of the combination of the first tube 10, the second tube 16, the third tube 20 and the fourth tube 22, also formed at the inner layer surface of the fifth tube 24. This connected combination of the first tube 10, the second tube 16, the third tube 20 and the fourth tube 22 shall be slid into the fifth tube 24 in coaxial structure.

[0045] According to FIG.11, one stem 34 is a conical glass post, one of its ends with smaller diameter can seal and fix the plural electrode 28 which is connected with a straight form cathode 26, one pipe 32 is connected with the sealed end of the fixed plural electrode 28, its opening hole 30 is located the sealed end and communicated with pipe 32.

[0046] According to FIG.12, and refer to the FIG.11, the electrodes 28 which is connected with a ring cathode 38.

[0047] According to FIG.13, a cap 36 its inner diameter is same as the outer diameter of the first tube 10, the outer diameter of cap 36 is the same as the diameter of the outer most discharge tube.

[0048] According to FIG.14, the structure of stem is same as FIG.11 above, however, for the conical glass post, the larger end is connected with a cap 36, the outer diameter of said the cap 36 is the same as the diameter of the outer most tube of the multi-tube fluorescent discharge lamp.

[0049] According to FIG.15 and refer to the FIG.14, the structure same as FIG.14, however, its electrodes 28 is connected with a ring cathode 38.

[0050] According to FIG.16 and refer to the FIG.9, also including plural number stem 34, said stem 34 includes a cathode 26, plural electrode 28, and connects with a cap 36, said cathode 26 is assembled in the two discharge chamber of the first tube 10 respectively, the outer diameter of the cap 36 is the same as that of the third tube 20.

[0051] According to FIG.17 and refer to the FIG.16, the cathode 26 of plural number stem 34 are slid into the two discharge chambers of the first tube 10 respectively, heating at the outskirts of the circumference at both ends of all the tubes, melting and sealing both ends of the tubes.

[0052] Or use the cathode 26 of plural number stem 34 with cap 36 is slid into the two discharge chambers of the first tube 10 respectively, heating on the circumferences of cap 36 correspond to the both ends of all the tubes, and at both ends of all the tubes can be melted and sealed. Due to the sealing of both ends of all discharge tubes and isolator 12 and through-hole 14 of the first tube 10 and the second tube 16, thus, forming successive discharge chambers.

[0053] According to FIG.18, the first tube 10 is a round straight glass tube, in which a pair of electrodes 28 and one pipe 32 with said tube are slid in coaxial structure, and heating at one end of the tube for softening, by means of clamping, pressing and sealing the tube, the pair of electrodes 28 and pipe 32 can be fixed, air is blown into the pipe 32, by means of the heating at the end of sealed, a hole 30 can be extruded, forming a phosphor layer 18 on the surface of said tube outside, install cathode 26 in the pair of electrode 28, and the other first tube 10 can be completed with the method mentioned above.

[0054] The second tube 16 is a round straight glass tube, its diameter is slightly larger than that of the first tube 10, the air is blown in at both ends of the second tube 16, or one end of said tube is air tight and the air is blown in from another end, also, heating is performed on the circumferences to approach both ends of the second tube 16, at the position of plural number thus extruding the through-hole 14 with plural number, and heating is also performed at the circumference to approach the middle of the second tube16, rotated with reverse direction at both

ends of the second tube, and is twisted at the softening place of the tube thus fusing into an isolator 12 to seal the path of the discharge tube and separate the discharge path of the second tube16.

[0055] The third tube 20 is a round straight glass tube, its diameter is slightly larger than that of the second tube 16, the phosphor layer 18 is formed in the inner layer surface of the third tube 20 and in the inner and outer layer surface of the second tube16.

[0056] The two cathodes 26 of the first tubes 10 can be slid into the two-discharge chamber of the second tube 16 in coaxial structure respectively, that the cathodes 26 installed oppositely to approach the isolator 12, heating at the outskirts of the circumference at both ends of the first tube 10 and the second tube 16, sealing both ends of the tubes, then slid into the third tube 20 in coaxial structure, heating at the outskirts of the circumference at both ends of the second tube 16 and the third tube 20, sealing both ends of all discharge tubes. Due to the sealing of both ends of all discharge tubes and isolator 12 and through-hole 14 of the second tube 16, thus, forming successive discharge chambers.

[0057] As mentioned above, heating at the outskirts of the circumference at both ends of the first tube 10, the second tube 16, the third tube 20 can make it soft and melt and seal both ends of all discharge tubes, also, a cap 36 can be placed at both ends of the multi-tube, after the cap 36 on the circumferences correspond to the both ends of all discharge tubes is heated, both ends of the first tube 10, the second tube 16, the third tube 20 can be melted and sealed, thus, forming successive discharge chambers.

[0058] For the multi-tube fluorescent discharge lamp with more than 5 tubes, which can be formed by means of the method mentioned above with the total tube number N (N= odd number), tube number of different tube with different diameter, the isolator 12 can be formed from the second tube 16 to the (N-1)th tube to approach the middle of the tubes. The through-hole 14 with plural number can be formed at the even number tube and from the second tube 16 to the (N-1)th tube to approach the both ends of the tubes at the position of circumference, the

through-hole 14 with plural number can be formed at the odd number tube from third tube 20 to (N-2)th tube to approach the both ends of the isolator 12 at the position of circumference.

[0059] The phosphor layer 18 coated on the inner and outer layer surface of the tube from the second tube 16 to the (N-1)th tube, and coated on the outer layer surface of the tube on the first tube 10, and coated on the inner layer surface of the Nth tube, a pair of electrode 28 of the cathode 26 connecting to terminal 42 of base 40 respectively.

[0060] According to FIG.19, the first tube 10 is a round straight glass tube, heating is performed at the circumference to approach the middle of the first tube 10, and rotation is made with reverse direction at both ends of the first tube 10, and is twisted at the softening place of the tube thus fusing into an isolator 12 to seal the pipeline of the first tube 10, thus, forming two discharge chambers, and air is blown in from both ends of said tube and heating is performed at the circumferences approach to the both ends, at the position of plural number to extrude the through-hole14 with plural number, forming the phosphor layer 18 on the inner and outer layer surface of said tube.

[0061] A second tube 16 is a round straight glass tube of which the diameter is slightly larger than that of the first tube 10, the phosphor layer 18 is coated on the inner layer surface of the second tube 16, then the first tube 10 be slid into the second tube 16 in coaxial structure, also, plural number stem 34, said stem 34 includes a cathode 26, a pair of electrode 28, a hole 30, a pipe 32, its plural number cathode 26 is placed in the two discharge chambers of the first tube 10. Heating is performed at the outskirts of circumference at both ends of the first tube 10 and the second tube 16 to melt and seal both ends of the first tube 10 and the second tube 16 with the stem 34, due to the isolator 12 and the through-hole 14 of the first tube 10, and the sealing of both ends of all discharge tubes, thus, forming successive discharge chambers.

[0062] For the multi-tube fluorescent discharge lamp with 4 tubes or more than 4 tubes, which can be formed by means of the method mentioned above with the

total tube number N (N= even number), tube number of different tube with different diameter, the isolator 12 can be formed from the first tube 10 to the (N-1)th tube to approach the middle of the tubes. The through-hole 14 with plural number can be formed at the odd number tube and from the first tube 10 to the (N-1)th tube to approach the both ends of the tubes at the position of circumference, the through-hole 14 with plural number can be formed at the even number tube from the second tube 16 to (N-2)th tube to approach the both ends of the isolator 12 at the position of circumference, also, with one cap 36 or the stem 34 connecting a cap 36 at both ends of the multi-tube to heat the cap 36 at the circumferences of both ends of the corresponding discharge tubes, both ends of all tubes can be melted and sealed, the phosphor layer 18 coated on the inner and outer layer surface of the tube from the second tube 16 to the (N-1)th tube, and coated on the outer layer surface of the first tube 10, and coated on the inner layer surface of the Nth tube, a pair of electrode 28 of the cathode 26 connecting to terminal 42 of base 40 respectively.

[0063] According to FIG.20 and refer to the FIG.10, also including plural number stem 34, said stem 34 includes a cathode26, a pair of electrode 28, and connects with one cap 36, said cathode 26 is assembled in the two discharge chambers of 10, the outer diameter of the cap 36 is the same as that of the third tube 20. The cathode 26 of plural number stem 34 is assembled in the two discharge chambers of the first tube 10 respectively, heating is performed at the outskirts of the circumference correspond to the both end of all tubes, its softening can melt and seal both ends of all tubes or plural number stem 34 connecting with cap 36 placed at both ends of the first tube 10, the second tube 16, the third tube 20, the fourth tube 22 and the fifth tube 24, heating on the corresponding position at the circumference of all discharge tubes of the two cape 36 can seal both ends of all tubes. Due to the isolator 12, the through-hole 14 and sealing of both ends of all discharge tubes, thus, forming successive discharge chambers.

[0064] For the multi-tube fluorescent discharge lamp with more than 5 tubes, which can be formed by means of the method mentioned above with the total tube number N (N= odd number), tube number of different tube with different diameter,

the isolator 12 can be formed from the first tube 10 to the (N-1)th tube to approach the middle of the tubes. The through-hole 14 with plural number can be formed at the even number tube and from the second tube 16 to the (N-1)th tube to approach the both ends of the tubes at the position of circumference, the through-hole 14 with plural number can be formed at the odd number tube from the first tube 10 to the (N-2)th tube to approach the both ends of the isolator 12 at the position of circumference, the phosphor layer 18 coated on the inner and outer layer surface of the tube form the first tube 10 to the (N-1)th tube, and the inner layer surface of the Nth tube, a pair of electrode 28 of the cathode 26 connecting to terminal 42 of base 40 respectively.

[0065] According to FIG.21 and refer to the FIG.17, one base 40 with a pair of terminal 42 at both ends of the three-tube fluorescent discharge lamp, the electrode 28 of the cathode welded on said terminal 42 respectively.

[0066] According to FIG.22, when negative HV presents at one of those electrode 26 in the first discharge tube 10, electrons released by its electrode are attracted by positive HV at another electrode 26 in another first discharge tube 10, for moving into second discharge tube 16 from through-hole 14 of the first discharge tube 10, via the third discharge tube 20 from through-hole 14 of the second discharge tube 16; electrons passing through the third discharge tube 20 enter into another end of second discharge tube 16 from through-hole 14 thereof, and into another end of the first discharge tube 10 from through-hole 14 thereof, then the electrons hit another electrode 26; the electrode 26 with positive charges are converted into negative charges during the next half cycle of the alternating current, with negative charges in said another end of discharge tube 10, to release the electrons traveling in reverse along the route of electron movement of the first half cycle to repeat the process upon arriving at the corresponding electrode 26 with positive charges during which electronic irons and ultraviolet excited by the discharge chamber of each discharge tube, the phosphor on the surface of each discharge tube will be impacted and to emit light.

[0067]

According to FIG.23, when negative HV presents at one of those electrode 26 in

the first discharge tube 10, electrons released by its electrode are attracted by positive HV at another electrode 26 in another first discharge tube 10, for moving into second discharge tube 16 from through-hole 14 of the first discharge tube 10, via the third discharge tube 20 from through-hole 14 of the second discharge tube 16, then fourth discharge tube 22 from through-hole 14 of the third discharge tube 20 and finally into the fifth discharge tube 24 from through-hole 14 of fourth discharge tube 22; electrons passing through the fifth discharge tube 24 enter into another end of fourth discharge tube 22 from through-hole 14 thereof, then into another end of third discharge tube 20 from through-hole 14 thereof and into another end of second discharge tube 16 from through-hole 14 thereof reaching another end of the first discharge tube 10 from through-hole 14 thereof, then the electrons hit another electrode 26; the electrode 26 with positive charges are converted into negative charges during the next half cycle of the alternating current, with negative charges in said another end of discharge tube 10, to release the electrons traveling in reverse along the route of electron movement of the first half cycle to repeat the process upon arriving at the corresponding electrode 26 with positive charges during which electronic irons and ultraviolet excited by the discharge chamber of each discharge tube, the phosphor on the surface of each discharge tube will be impacted and to emit light.

[0068] According to FIG.24, at the related positions between all discharge tubes, the isolator 12 formed at the first tube and second tube to approach the middle of these tubes, the cathode 26 is located in the discharge chambers of the first tube 10 respectively. Forming through-hole 14 with plural number at the circumference to approach the both ends of the isolator 12 of the first tube 10, forming through-hole 14 with plural number at the circumference to approach the both ends of the second tube 16. The phosphor layer 18 coated on the inner and outer layer surface of the first tube 10, the second tube 16 and the inner layer surface of the third tube 20, a pair of electrode 28 of the cathode 26 connecting to terminal 42 of base 40 respectively.

[0069] According to FIG.25, at the related positions between all discharge tubes, the isolator 12 formed at the first tube 10, the second tube 16, the third tube 20 and

fourth tube 22 to approach the middle of these tubes, the cathode 26 is located in the discharge chambers of the first tube 10 respectively. Forming through-hole 14 with plural number at the circumference to approach the both ends of the isolator 12 of the first tube 10 and the third tube 20, forming through-hole 14 with plural number at the circumference to approach the both ends of forming through-hole 14 with plural number the second tube 16 and fourth tube 22. The phosphor layer 18 coated on the inner and outer layer surface of the first tube 10, the second tube 16, the third tube 20, the fourth tube 22, and the inner layer surface of the fifth tube 24, a pair of electrode 28 of the cathode 26 connecting to terminal 42 of base 40 respectively.

[0070] Subsequently, Heating on outside of the combination of tubes; meanwhile, blowing in dry air from one of the pipe 32 and exhausted from the other pipe 23, to accelerate drying the phosphor layers. After the drying process completed, one of the pipe 23 is heated and sealed, then several mg of mercury (Hg) is injected into the discharge chamber from the opening pipe 32, then the discharge chamber is vacuumed and then filled with little of Ar gas such as several hundreds Pa in pressure, and then sealing the pipe 23. Afterward the combination of tubes is put in an environment of electromagnetic field such as microwave chamber to agitate the liquid Hg into vapor Hg, applying current and high voltage on the both cathodes, a glow discharge will be generated in the discharge lamp.

[0071] It will be now apparent to those skilled in the art that other embodiments, details and uses can be made consistent with the letter and spirit of the foregoing disclosure and within the scope of this patent, which is limited only by the following claims, construed in accordance with the patent law, including the doctrine of equivalents.